

YEAR-END REPORT
FOR THE 2006 FIELD SEASON
AT LEVIATHAN MINE
Alpine County, California

January 2007

Prepared by:

California Regional Water Quality Control Board, Lahontan Region

To comply with:

**Paragraph No. 35 of USEPA's July 19, 2000 Administrative Abatement Action,
as amended.**

**LEVIATHAN MINE
YEAR-END REPORT FOR 2006 FIELD SEASON**

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1. BACKGROUND

Leviathan Mine is an inactive sulfur mine that the State of California acquired in the early 1980s in order to clean up water quality problems caused by historic mining. Jurisdiction over Leviathan Mine rests with the State Water Resources Control Board, which, in turn, has delegated jurisdiction over clean up work to the California Regional Water Quality Control Board, Lahontan Region (Lahontan Water Board).

The former sulfur mine is located on the eastern slope of the Sierra Nevada Mountains in Alpine County, California, in the upper portions of the Bryant Creek watershed, as shown in Figure 1. The current boundary of the Leviathan Mine site encompasses thirty-two patented mineral claims and a patented mill site, which together total 656.09 acres. The state-owned portion of the Leviathan Mine site encompasses approximately 475.70 acres. Mining disturbance is evident on approximately 231 acres. The majority of mining disturbance is on state-owned property, with approximately 21 acres of disturbance found on property owned by the United States Department of Agriculture, Forest Service, Humboldt-Toiyabe National Forest (USFS). Leviathan Mine is approximately six miles east of Markleeville, California and five miles west of Topaz Lake, Nevada. The USFS owns the majority of surrounding land, with the exception of ten private parcels along the southern boundary of the mine site.

As shown in Figure 2, Leviathan and Aspen Creeks flow across the mine site and eventually join just below the mine. Approximately 1.5 miles downstream of the confluence of Leviathan and Aspen Creeks, Leviathan Creek joins Mountaineer Creek. The combined flow of Leviathan and Mountaineer Creeks forms Bryant Creek. Approximately 3.5 miles downstream of the confluence of Leviathan and Mountaineer Creeks, Bryant Creek flows across the Nevada state line. Approximately 1.8 miles downstream of the Nevada state line there exists an irrigation structure that enables the diversion of water from Bryant Creek to an irrigation ditch. The irrigation ditch is used seasonally to divert flow from Bryant Creek to the River Ranch property, owned by Park Cattle Company. From the irrigation diversion, the natural course of Bryant Creek continues to the northwest, and approximately 1.5 miles downstream from the irrigation diversion, Bryant Creek joins the East Fork of the Carson River.

Historic mining activities at Leviathan Mine included underground and open pit extraction of sulfur. These activities resulted in the exposure of certain minerals (e.g., pyrite) contained in the native soil and rock to air and water. This exposure triggers a series of chemical reactions that cause the ground water to become acidic. As the acidic ground water moves through the soil and around rocks, it dissolves metals in the ground. Eventually, the acidic ground water encounters the ground surface in the form of a seep or spring. Acidic- and metal-rich water seeping out of the ground is referred to as acid mine drainage (AMD). If left unabated, the AMD enters nearby creeks (Leviathan and Aspen) causing significant adverse impacts. In addition, historic mining activities resulted in significant soil disturbance, erosion, and sediment deposition to nearby receiving waters.

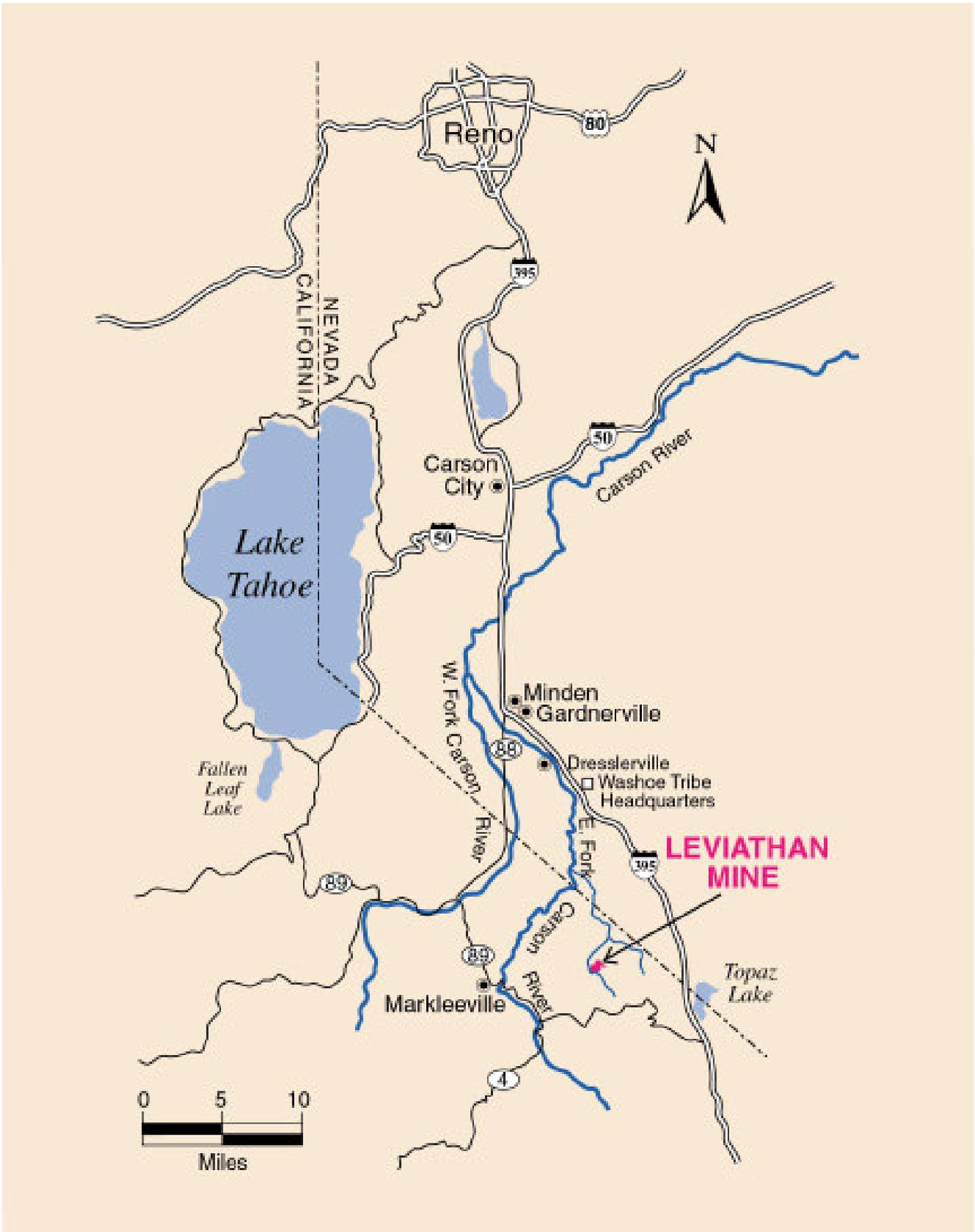


FIGURE 1
SITE LOCATION

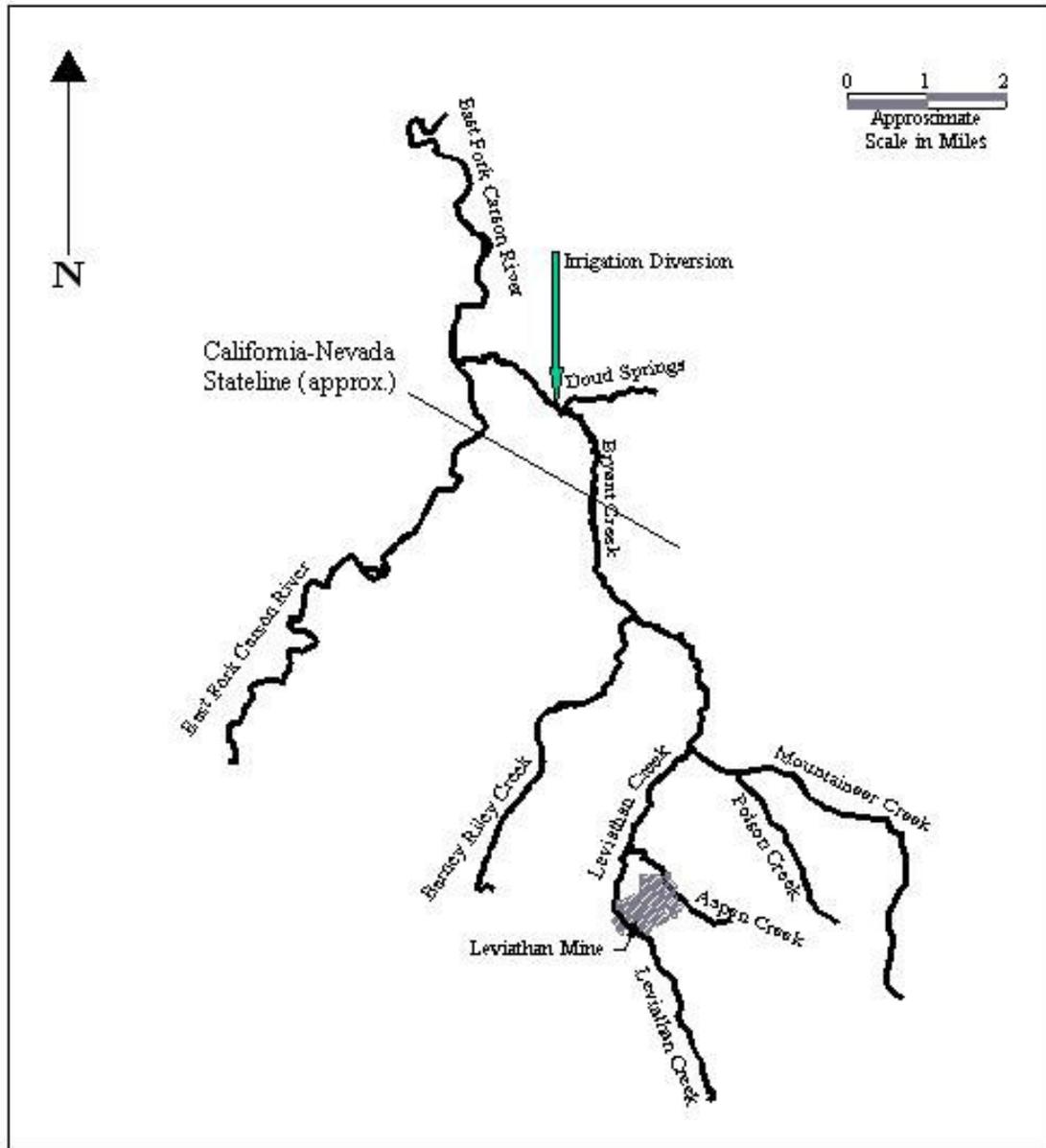


Figure 2. Leviathan Creek and Receiving Waters

Acting on the State's behalf, the Lahontan Water Board has implemented several projects to abate and quantify the discharge of pollutants from Leviathan Mine. In 1985, the Lahontan Water Board completed construction of a pollution abatement system at Leviathan Mine to address specific problem areas. The 1985 project reduced the pollutant load to receiving waters. However, the project was not intended to address all sources of pollution.

In May 2000, the United States Environmental Protection Agency (USEPA) placed Leviathan Mine on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List, thus making Leviathan Mine a federal Superfund site. Because the State of California is the present property owner, USEPA has identified the State as a Potentially Responsible Party. USEPA may direct Potentially Responsible Parties to take certain actions to characterize and abate pollution at Superfund sites.

On July 19, 2000, pursuant to its authority under CERCLA, USEPA issued an Administrative Abatement Action (AAA) to the Lahontan Water Board and, thereby, directed the Lahontan Water Board to implement certain pollution abatement and site characterization activities at Leviathan Mine. With only slight modification, USEPA reissued the AAA in 2001, 2002, 2003, 2004, 2005, and again in 2006. It is expected that USEPA will continue to direct Lahontan Water Board work at Leviathan Mine through annual reissues of the AAA, until a remedy addressing all releases of hazardous substances at Leviathan Mine is implemented (potentially by other parties).

The Lahontan Water Board shall cooperate with USEPA in providing information regarding the work to the public. As requested by USEPA, the Lahontan Water Board shall participate in the preparation of such information for distribution to the public and in public meetings which may be held or sponsored by USEPA to explain activities or relating to the Site. This year-end report was created to comply with Paragraph 35 of USEPA's July 19, 2000 Administrative Abatement Action, as amended, which requires the Lahontan Water Board to explain activities relating to the Site.

2. 2006 LAHONTAN WATER BOARD ACTIVITIES

Lahontan Water Board activities for the 2006 field season included: 1) treatment of AMD held in evaporation ponds (pond water treatment); 2) continued implementation of surface water monitoring; and 3) site maintenance. Lahontan Water Board staff conducted each of the above-listed activities in accordance with *Work Plan for 2006 Site Work by the California Regional Water Quality Control Board at Leviathan Mine* (Work Plan) transmitted to USEPA in June 2006.

3. POND WATER TREATMENT

3.1 Background

As mentioned in Section 1, the Lahontan Water Board completed a pollution abatement system at Leviathan Mine in 1985 that addressed specific problem areas. The 1985 abatement system included construction of five lined evaporation

ponds (see Figure 3) to capture and evaporate AMD from remnant underground mine workings. The primary sources of AMD to the pond system are the “Adit” and the Pit Under-Drain (PUD).

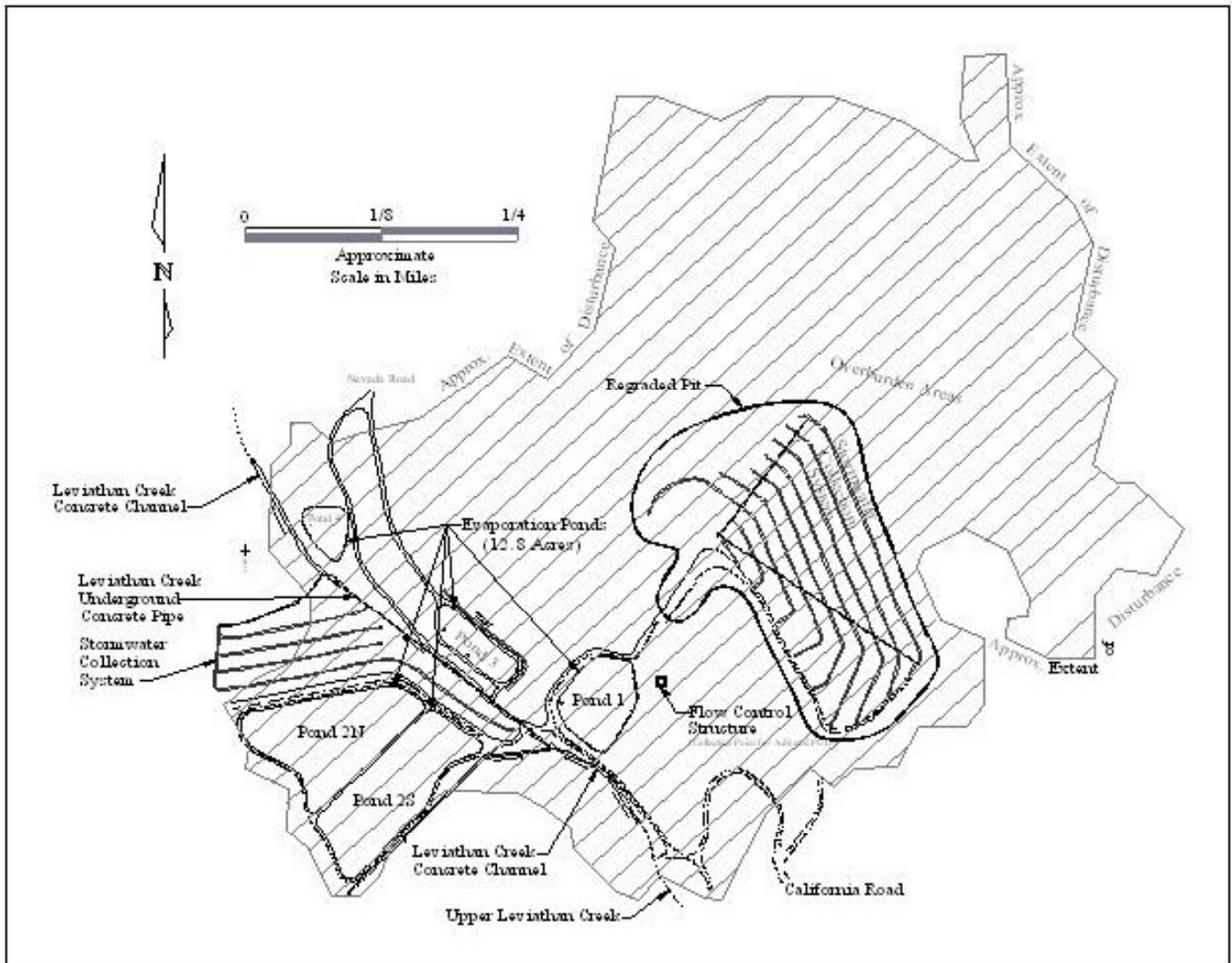


Figure 3. 1985 Site Improvements

The Adit is a remnant tunnel from underground mining activities that occurred in the 1930s. The exact condition of the interior of the Adit is unknown, but it is likely that portions of the tunnel have collapsed. The tunnel extends from a point approximately 80 feet east of Pond 1 in an easterly direction, beneath the floor of the open pit, to a point approximately 1,000 feet on the east side of the open pit. The Adit intercepts and conveys groundwater in a westerly direction, towards the evaporation pond system. Acidic groundwater from the Adit has a pH of less than 3.0 and typically has had a flow rate between 9 and 42 gallons per minute (gpm), based on United States Geological Survey (USGS) data from 1999 to 2006.

As part of the State's 1985 pollution abatement project, the State installed an underground drain to collect acidic groundwater emanating from the Adit. The underground drain consists of 12-inch perforated pipe positioned in a bed of drain rock having approximate dimensions 8-feet wide, 15-feet long, and 3-feet deep. The bed of drain rock is located at the collapsed westerly end of the Adit, approximately 80 feet east of Pond 1, and approximately 10 feet above the overflow elevation of Pond 1. The underground drain is completely buried in native material. The perforated pipe is connected to a non-perforated 12-inch pipe that carries the acidic drainage to a concrete box in which the drainage can be routed to the evaporation pond system or to Leviathan Creek.

The Lahontan Water Board installed the PUD during construction of the 1985 pollution abatement project to dewater saturated soils in the bottom of the open pit. Dewatering of the pit bottom was necessary for completion of excavation work in the pit. The PUD consists of approximately 1,900 linear feet of collector piping in the floor of the open pit. The collector piping consists of a 12-inch perforated pipe laid in a 3-foot by 3-foot trench filled with drain rock. The depth of the collector pipes is no greater than 30 feet below the elevation of the pit bottom. The collector pipes are completely buried in pit backfill material. The collector pipes eventually connect to a non-perforated 18-inch pipe that carries subsurface drainage from the PUD to a concrete box in which the drainage can be routed to the evaporation pond system or to Leviathan Creek (the same box that the Adit water is carried to). Acidic drainage from the PUD has a pH of less than 3.0 and typically has had a flow rate between 0.1 and 38 gpm, based on data between 1999 and 2006.

Leviathan Mine is located in mountainous terrain with minimal flat surface area. Given the limited usable area at the mine site, the evaporation ponds could not be sized to provide 100 percent containment of influent flows (consisting of AMD from the Adit and PUD, and direct rain/snow onto the ponds). The evaporation ponds cover a cumulative surface area of approximately 12.8 acres with a cumulative holding capacity of approximately 16 million gallons (based on an October 1998 survey conducted by ARCO Environmental Remediation, LLC).

To prevent pond overflows, the Lahontan Water Board treats pond water during the summer months to increase pond storage capacity for the subsequent winter and spring months. The Lahontan Water Board assembled a treatment system

during the 1999 field season on the north east corner of Pond 1 and tested the process at full-scale during the 1999 and 2000 field seasons. The typical field season at Leviathan Mine runs from mid-June through mid-October. The Lahontan Water Board has continued to operate the lime treatment system adjacent to Pond 1 during the summer months from 2001 through 2006.

Following unusually wet winters in 2005 and 2006, and the resulting large quantities of AMD contained in the pond system, the Lahontan Water Board implemented additional pond water treatment capabilities in an effort to prevent untreated discharges to Leviathan Creek. A smaller and more portable treatment system was assembled and tested adjacent to Pond 3 in the spring of 2005 and proved effective at treating AMD. The treatment system was mobilized and operated at the site without requiring the heavy equipment used for operational support of the treatment system adjacent to Pond 1. The portable treatment system, with minor improvements, was employed again at full scale in the spring of 2006.

3.2 2006 Pond Water Treatment

The Lahontan Water Board's 2006 treatment of AMD contained in the pond system is described as lime neutralization. The neutralization of AMD by the addition of alkalinity has long been accepted as an effective means to raise pH and remove metals in AMD. A source of alkalinity, such as lime (calcium hydroxide or $\text{Ca}[\text{OH}]_2$), is mixed into the AMD from the pond system. The addition of alkalinity causes an increase in pH and the precipitation of dissolved constituents, including metals contained in the AMD. The precipitated metals are then separated from the solution, and the final products are 1) a nearly metal-free effluent with near neutral pH, and 2) waste sludge. Two lime treatment systems were used to treat AMD contained in the pond system in 2006: Pond 3 Lime Treatment System (also known as Spring Treatment) and Pond 1 Lime Treatment Plant (also known as Summer Treatment).

Pond 3 Lime Treatment System

Above average precipitation during the 2005 and 2006 winter resulted in an increase in the volume of direct precipitation into the evaporation pond system and elevated flow rates in the primary sources of AMD to the pond system (Adit and PUD). Due to these conditions, the pond system was filling at a faster rate than had been observed in previous years. Staff monitors PUD and Adit flow rates and Pond 1 stage (i.e., water level) remotely in real time and compares these data to historical flow rates and stage readings to attempt to anticipate pond system overflow into Leviathan Creek. In an effort to minimize the potential of AMD and direct precipitation contained in the pond system from overflowing into Leviathan Creek, the Lahontan Water Board and their contractor implemented an in-situ system in April 2006 to treat AMD and direct precipitation contained in Pond 3.

The treatment system introduced lime into Pond 3 using a Rotating Cylinder Treatment System-High Speed (RCTS-HS) system. The removal of snow from

the site access road and mobilization of the treatment system to the site began on April 10, 2006, and treatment of water contained in Pond 3 began on April 14, 2006. Pond 3 had been filled to capacity, predominantly with direct precipitation, and had commenced overflowing to Leviathan Creek sometime between April 12 and April 13, 2006. Treatment of AMD utilizing the RCTS-HS system continued until July 11, 2006. A total of approximately 7.5 million gallons of treated water was discharged to Leviathan Creek during multiple controlled discharges from Pond 3 using discharge requirements established for pond water treatment (Table 1). By July 11, 2006, it was evident that the threat of pond overflow from Ponds 1, 2 north, and 2 south (known as the upper ponds) had diminished due to increased evaporation rates and the startup of the lime treatment plant on the northeast corner of Pond 1. The last discharge out of Pond 3 was on July 11, 2006.

Sludge generated during the treatment process was contained in the bottom of Pond 3. Most of the sludge was dry enough (due to evaporation) to be removed by early October 2006. In early November 2006, approximately 159 tons of sludge were removed from Pond 3 and disposed of in a Class I hazardous waste landfill in Beatty, Nevada. Residual sludge remaining in Pond 3, which was too wet for transport to the landfill, was gathered into stockpiles within the confines of Pond 3 in an effort to maximize the capacity of Pond 3.

The RCTS-HS system was effective in treating impacted water in Pond 3. Sand covering the Pond 3 liner contains acidity from Pond 3 AMD residue concentrated by evaporation over the years and because the sand was originally acidic waste rock. The acidic sand consumed alkalinity over time and caused a drop in pH when the system was shut down for any reason. The drop in pH complicated neutralization and proper timing of the discharge was required to minimize the mobilization of acidity and metals.

A detailed report describing the 2006 Pond 3 treatment activities titled *Data Summary Report for Pond 3 Emergency Treatment at the Leviathan Mine 2006* is included as Appendix C.

Pond 1 Lime Treatment Plant

The lime treatment plant located on the northeast corner of Pond 1 was modified slightly during the 2005 treatment season to increase the treatment rate of AMD contained in the pond system following an unusually wet winter. The modifications implemented during the 2005 treatment effort indicated that treatment rates of up to approximately 200 gallons per minute could be sustained reliably over extended periods. Modifications performed in 2005 also included eliminating required collection, sample preparation, and field analysis of mid-process samples, which had the additional benefit of significantly improving worker safety. However, laboratory testing demonstrated that the sludge produced would exceed the Total Threshold Limit Concentration (TTLC) for arsenic, which is 500 milligrams per kilogram (mg/kg). When the total concentration of any constituent equals or exceeds its TTLC, by California standards, the waste is considered to be hazardous.

In the late winter of 2006 it became apparent that the upper ponds would likely be filled to capacity with AMD and direct precipitation. The upper ponds reached their capacity and began overflowing to Pond 3 sometime on April 12, 2006. Pond 3 in-situ treatment efforts commenced on April 13, 2006 (see above). In mid June 2006, the upper ponds stopped overflowing into Pond 3. From mid June through July 7th, AMD from the upper ponds was brought down to Pond 3 by use of a siphon. The contractor continued treating the AMD in Pond 3 until July 11th. By June 7, 2006, the upper ponds contained approximately 14.5 million gallons of AMD requiring treatment. Typically in June, a natural equilibrium is established between the flow into the ponds from the PUD and Adit and the water losses due to evaporation. This equilibrium did not occur before the upper ponds overflowed into Pond 3 in April 2006.

Reliable access to the site by heavy equipment was reestablished in mid-June 2006 following substantial repairs to site access roads (see Section 5.2). Approximately 716 tons of sludge generated during the 2005 treatment season were removed from the Pit Clarifier in late June 2006 and disposed of in a Class I hazardous waste landfill in Beatty, Nevada by mid-July. While sludge was being removed from the Pit Clarifier for disposal, contractors assembled the treatment plant and incorporated modifications made during the 2005 treatment season that allowed treatment rates of up to 200 gpm. The Pond 1 Lime Treatment Plant contractor began treating AMD contained in the pond system on June 27, 2006. The contractors began discharging treated water to Leviathan Creek on June 30, 2006.

Two points of lime addition remained as they had been in past treatment seasons in an effort to preserve known treatment plant responses (e.g., chemical and mechanical) from operator input, minimize treatment plant and water quality disruptions, and to improve lime mixing and utilization. The treatment plant was shut down on August 12, 2006 after all the AMD in Ponds 2 north and 2 south were drained into Pond 1 and all the AMD in Pond 1 was treated. By August 28, 2006 approximately 13.2 million gallons of treated pond water had been discharged out of the Pit Clarifier to Leviathan Creek. The approximately 1.3 million-gallon difference between 14.5 million gallons in the ponds prior to starting treatment and 13.2 million gallons treated is attributed to evaporation and from the Pond 3 treatment contractor bring AMD down from the upper ponds into Pond 3 for treatment.

Discharge of treated pond water from the Pond 1 Lime Treatment Plant to Leviathan Creek is governed by discharge standards in USEPA's 2005 Non-Time Critical Removal Action Memo, as shown in Table 1.

Table 1. 2006 Discharge Criteria for Pond Water Treatment

Water Quality Parameter	MAXIMUM	FOUR DAY AVERAGE
pH	--	Between 6.0 – 9.0 SU _{f2}
Arsenic	0.34 mg/L _{f1}	0.15 mg/L _{f4}
Aluminum	4.0 mg/L _{f1}	2.0 mg/L _{f4}
Cadmium	0.009 mg/L _{f1}	0.004mg/L _{f4}
Chromium	0.97 mg/L _{f1}	0.31 mg/L _{f4}
Copper	0.026 mg/L _{f1}	0.016 mg/L _{f4}
Iron	2.0 mg/L _{f1}	1.0 mg/L _{f4}
Lead	0.136 mg/L _{f1}	0.005 mg/L _{f4}
Nickel	0.84 mg/L _{f1}	0.094 mg/L _{f4}
Selenium (Total Recoverable)	Not Promulgated _{f3}	0.005 mg/L _{f4}
Zinc	0.21 mg/L _{f1}	0.21 mg/L _{f4}

mg/L..... Milligrams per liter

f1..... Dissolved concentration in a daily grab sample that has been field-filtered (0.45 micron) and acid fixed.

f2..... pH measurement based on 24-hour average discharge.

f3..... Total recoverable concentration in a daily grab sample that is acid fixed, but not filtered.

f4..... The sum of the detected concentration in four daily grab samples, from four consecutive discharge days, divided by four. If the concentration detected by the laboratory is less than the detection limit, one-half of the detection limit shall be used in calculating the Average concentration.

3.3 Pond 1 Lime Treatment Plant Process

The Pond 1 Lime Treatment process treats the AMD stored in all three upper ponds. The process is referred to as Pond 1 treatment because the treatment plant draws the AMD from Pond 1; AMD from Pond 2 north and Pond 2 south flow to Pond 1 during the treatment season.

The Pond 1 Lime Treatment Plant operates optimally in the warm summer months. Cold temperatures encountered in the late summer and early fall appear to cause slow reaction times, and consequently, decreases in treatment rates.

A 5-horsepower (hp) electric pump conveyed AMD from Pond 1 to a 10,000-gallon fiberglass Phase 1 reaction tank (R-1). A pH probe installed in R-1 measured pH in R-1 and controlled the amount of lime slurry added to R-1. A 3-hp mixer on R-1 mixed AMD and lime slurry. The lime slurry raised the pH of the AMD from 2.5 to an approximate range of 3.1 to 3.4.

The partially treated AMD then flowed by gravity from R-1 through a two-chambered combination flash/flocculation mix tank and into a Lamella clarifier (CL-1) where precipitates settled.

Two 1.5-inch air diaphragm pumps removed precipitates from the bottom of CL-1. One of the 1.5-inch diaphragm pumps was used to pump a portion of the precipitates back into the top of R-1. The second 1.5-inch air diaphragm pump was used to pump remaining precipitates from the bottom of CL-1 back into the top of CL-1 in an effort to keep precipitates from settling out and potentially clogging the bottom of CL-1 with solids.

Supernatant and precipitates from CL-1 flowed by gravity to the Phase 2 reaction tank (a second 10,000-gallon fiberglass tank) referred to as R-2. A pH probe in R-2 measured pH and controlled the amount of lime slurry added to R-2. A 7.5-hp mixer on R-2 mixed the partially treated AMD, precipitates, and lime slurry. In R-2, the lime slurry raised the pH of the partially treated AMD to approximately 8.5, which caused all but trace amounts of remaining metals to precipitate out of solution.

Treated AMD and precipitates then flowed through the Phase 2 flash/flocculation mix tank and into the Phase 2 Lamella clarifier (CL-2). Two 10-hp mud pumps transferred the water/solid mixture from the bottom of CL-2 to the Pit Clarifier. Polymer solution (Superfloc A-1849 RS Anionicpolyacrylamide water-in-oil emulsion, or equivalent) was injected into the sludge slurry line just upstream of the two 10-hp mud pumps.

The Pit Clarifier is an earthen reservoir located in the bottom of the Leviathan Mine open pit. The Pit Clarifier has plan dimensions of approximately 150-feet by 150-feet, and includes a perforated pipe and gravel/sand under-drain. When the treatment plant was treating AMD, the sludge slurry from CL-2 was pumped to the Pit Clarifier where solids settled out in near-quiescent conditions. Water can be discharged from the Pit Clarifier via a surface decant structure or via an under-drain. Clean water was decanted from the Pit Clarifier via an adjustable outlet and conveyed by gravity to a weir box used for final effluent monitoring and discharge. If discharge from the Pit Clarifier was found to be out of compliance (by field analysis or direct knowledge of system upset), discharge was stopped. A valve prior to the weir box was also available to divert discharge back to Pond 1 for re-treatment, if required.

The Pit Clarifier under-drain was used continuously during the 2006 treatment season to more accurately regulate the flow being discharged to the weir box. Using the under-drain continuously during 2006 treatment operations had the added benefit of utilizing the gravel/sand lining the bottom of the Pit Clarifier for additional filtration and clarification for the treated water. Once treatment ended, and discharge through the adjustable outlet (decant outlet) ended, treated water was then discharged only via the Pit Clarifier under-drain and the weir box. Daily sampling of the discharge from the under-drain occurred until the flow rate out of the under-drain dropped below approximately 4 gpm.

3.4 Sampling and Analysis for Pond 3 Lime Treatment

Sampling methodology and analytical procedures for aqueous samples collected during Pond 3 lime treatment followed protocols detailed in the *Sampling and Analysis Plan for Leviathan Mine Surface Water Monitoring (January 2004)*. Samples were collected of effluent, influent, and sludge generated by treatment. Sampling procedures are described briefly below. Additional information can be found in the *Data Summary Report for Pond 3 Emergency Treatment at Leviathan Mine 2006* (Appendix C).

Sampling

As a means to demonstrate that the Pond 3 treatment system was providing acceptable effluent for discharge to Leviathan Creek, Lahontan Water Board staff collected a grab sample of the treated effluent each day that effluent was discharged to the creek. Influent samples from the upper ponds were collected sporadically throughout treatment. Samples were submitted to the Lahontan Water Board's contract laboratory to be analyzed for dissolved aluminum, arsenic, copper, chromium, cadmium, nickel, iron, lead, and zinc and total recoverable selenium. Dissolved metals and total recoverable selenium samples were field filtered and preserved with nitric acid.

The Lahontan Water Board's contractor conducted field monitoring of the water in Pond 3 multiple times per day to determine treatment progress. The contractor monitored Pond 3 water from two to 14 times per day, more frequently during times of discharge. Field monitoring included the measurement of flow, pH, oxidation-reduction potential, conductivity, dissolved oxygen, and temperature.

Lahontan Water Board staff collected sludge generated by the Pond 3 treatment system. Sludge was sampled to determine if the sludge is considered a hazardous waste and as a qualitative evaluation of the AMD that generates the sludge.

Three sludge samples were collected from the effluent stream of the RCTS-HS prior to deposition in Pond 3. These three composite sludge samples represent three different time periods of operation. Samples were obtained by collecting a portion of slurry discharged out of the RCTS-HS prior to entering Pond 3 in a five-gallon plastic container. Solids were allowed to settle out of solution and the relatively clear treated water was decanted off the top of the sludge. The remaining sludge was air dried for approximately eight weeks.

Lahontan Water Board staff collected one additional sludge sample directly from Pond 3 following system shutdown and partial drying of the sludge in early August 2006. The sample was collected approximately seven weeks after the treatment system was shut down.

Sludge samples were prepared in the field laboratory and sent to the Water Board's contract laboratory for Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) analyses for Title 22 Metals (i.e., the 17 metals whose analyses are specified in Title 22 of the California Code of Regulations. These metals are antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc), and aluminum and iron.

Results

Pond 3 treatment system analytical results are presented and discussed in the *Data Summary Report for Pond 3 Emergency Treatment at Leviathan Mine, 2006* (Appendix C). Analytical results were generated by the Lahontan Water Board's contract laboratory by applying standard analytical methods.

The sludge sample collected directly from Pond 3 contained approximately 14 percent solids. The low solids content is most likely due to the short time period between treatment operations and sample collection.

With the exception of the TTLC and STLC analysis for arsenic, the sludge did not exceed any other STLC or TTLC limits.

3.5 Sampling and Analysis for Pond 1 Lime Treatment

Sampling and analysis associated with treatment of Pond 1 water was performed in accordance with the Lahontan Water Board's *Sampling and Analysis Plan for Leviathan Mine Site Pond Water Treatment (June 2006)*. Lahontan Water Board staff collected daily grab samples of treated effluent while water was being discharged to Leviathan Creek. Staff also collected and analyzed samples of influent AMD (pond water) and sludge generated by treatment.

Sampling

As a means to demonstrate that the treatment systems were providing acceptable effluent for discharge to Leviathan Creek, Lahontan Water Board staff collected a daily grab sample of the treated effluent. A portion of the grab sample was field filtered and preserved with nitric acid, and submitted to the Lahontan Water Board's contract laboratory to be analyzed for dissolved aluminum, arsenic, copper, chromium, cadmium, nickel, iron, lead, and zinc. An unfiltered portion of the daily grab sample was preserved with nitric acid and submitted for analysis for total recoverable selenium. Staff also requested total metals analyses of the effluent.

Once per week, Lahontan Water Board staff submitted samples of treated effluent and untreated influent for the following analysis: sulfate (SO₄), total dissolved solids, dissolved aluminum, arsenic, copper, chromium, cadmium, nickel, iron, lead, zinc, calcium, cobalt, manganese, magnesium, and total recoverable selenium.

To provide "real-time" information regarding metals concentrations and other parameters in the treated effluent from the Pond 1 treatment plant, Lahontan Water Board staff planned to collect and field-analyze at least two grab samples of effluent per day for pH, dissolved aluminum, and dissolved iron. The spectrophotometer that analyzes aluminum and iron (a DR model 2010 manufactured by the Hach Company) malfunctioned in late June and was returned to the company for repair. The Hach company was unable to loan the Water

Board a spectrophotometer so no field analysis of aluminum and iron occurred from late June until the beginning of August. Water Board staff continued to measure and record pH data throughout the duration of treatment. In addition, treatment system operators measured effluent pH at least once every two hours throughout treatment. pH measurements taken by Lahontan Water Board staff confirm that the discharge of treated effluent to Leviathan Creek was within USEPA's discharge criteria for pH, and are included in the *Data Summary Report for 2006 Pond 1 Lime Treatment* (Appendix A).

Sludge was sampled to determine if the sludge is considered a hazardous waste and as a qualitative evaluation of the AMD that generates the sludge. Sludge generated by the Pond 1 treatment system, contained in the Pit Clarifier, was sampled directly from the Pit Clarifier following partial dewatering of sludge in October 2006. Sludge samples were analyzed by the Lahontan Water Board's contract laboratory, according to appropriate analytical procedures, to provide comparisons with the TTLC and STLC for Title 22 metals, aluminum, and iron.

Staff sampled sludge directly from the Pit Clarifier approximately eight weeks after the treatment system was shutdown. At the time of sampling, there was no discharge of treated water from the Pit Clarifier under-drain. Three sludge samples were collected from three different locations in the Pit Clarifier. Sludge samples were collected in a vertical profile that represented the complete interval of sludge from the upper surface of sludge down to the base of the sludge.

Results

The results of laboratory analysis of aqueous and sludge samples for the Pond 1 treatment system are included in the *Data Summary Report for 2006 Pond 1 Lime Treatment* (Appendix A). Analytical results were generated by the Lahontan Water Board's contract laboratory by applying standard analytical methods.

The four-day arithmetic average concentration for aluminum discharged to Leviathan Creek was exceeded during initial plant startup from July 3 through July 5, 2006 and again from July 8 through July 11, 2006. The cause for elevated aluminum concentration is believed to be the result of the lime-dosing set point in Reactor 2 being set slightly higher than was required. Following laboratory confirmation of initial aluminum discharge exceedences, the lime-dosing set point was adjusted to minimize aluminum discharge concentrations while still not exceeding nickel discharge concentrations. Once optimum treatment system set points were established during the initial two-week startup period, no exceedences of the daily maximum or four-day arithmetic average concentrations occurred.

The three sludge samples collected from the Pit Clarifier averaged approximately 21.4 percent solids. The low solids content is most likely due to the short time period between treatment operations and sample collection.

The three grab samples from the Pit Clarifier contained constituents in excess of the TTLC and STLC analytical thresholds. The TTLC concentration for arsenic was exceeded in all three samples collected from the pit clarifier. The hazardous

waste threshold for TTLC arsenic is 500 mg/kg. The STLC concentration for nickel was exceeded in one of the three samples collected. The arithmetic average STLC nickel concentration for the three samples is 16.7 mg/L. The STLC for nickel is 20 mg/L.

With the exception of the TTLC analysis for arsenic and the STLC analysis for nickel, the sludge did not exceed any other STLC or TTLC limits.

3.6 Summary

Implementation of pond water treatment in 2006 was consistent with the Lahontan Water Board's 2006 Work Plan. In-situ treatment of water contained in Pond 3 was implemented from mid-April through early July 2006. Approximately 7.5 million gallons of water treated in the Pond 3 treatment plant was discharged to Leviathan Creek. The Pond 1 treatment plant operated from late June 2006 through mid-August 2006. Approximately 13.2 million gallons of water treated in the Pond 1 treatment plant were discharged to Leviathan Creek from the Pit Clarifier.

Pond 3 Lime Treatment Plant

The 2006 in-situ treatment of Pond 3 consumed approximately 42.5 tons of dry lime to treat approximately 7.5 million gallons of varying concentrations of AMD mixed with direct precipitation. Sludge generated during the treatment process was contained in Pond 3. A portion of the sludge contained in Pond 3 was removed and disposed of at a Class 1 hazardous waste facility in Beatty, Nevada in November 2006. The in-situ treatment process combined with natural evaporation resulted in Pond 3 having a storage capacity of approximately one million gallons by the end of the treatment season. Atlantic Richfield Company (ARC) continued to use Pond 4 as part of their efforts to treat other sources of AMD in 2006.

Pond 1 Lime Treatment Plant

Seven hundred and sixteen tons of sludge generated during the 2005 treatment season by the Pond 1 treatment plant and deposited in the Pit Clarifier, was disposed of at a Class 1 hazardous waste facility in Beatty, Nevada. During the 2006 season, the Pond 1 treatment plant generated an estimated 1100 cubic yards (wet volume) of sludge. Sludge generated by the Pond 1 treatment plant in 2006 was contained in the Pit Clarifier and will be disposed of at a Class I hazardous waste facility in the spring of 2007 following final sludge dewatering and corresponding increase in solids content.

The 2006 upper ponds treatment effort consumed approximately 180 dry standard tons of lime; 4,236 pounds of polymer; 6,294 gallons of diesel fuel; and 756 gallons of gasoline. The Lahontan Water Board's treatment effort combined with natural evaporation resulted in the upper pond system having a storage capacity of approximately 14 million gallons at the end of the treatment season.

There remain some unavoidable issues mostly related to the remoteness of the mine site. The remote location results in logistical obstacles for the delivery of consumables for plant operation (lime, fuel, etc.). Rough road conditions can also hamper site access. The USFS and Alpine County, working with Lahontan Water Board staff, conducted road improvement projects along the California access road (see Site Maintenance section for more information).

4. SITE MONITORING

The Lahontan Water Board continued their efforts to monitor surface water flow and quality, and to collect meteorological information in the vicinity of Leviathan Mine. Additionally, depth to groundwater was measured sporadically (see Table 4) in Monitoring Well-3.

4.1 Flow Monitoring

Flow monitoring for the 2005-2006 water year (October 1, 2005 through September 30, 2006) at Leviathan Mine continued under contract between the Lahontan Water Board and the USGS. Flow monitoring occurred as detailed in Table 2. Daily average flow data for stations with continuous recorders are included in the *Data Summary Report for 2006 Surface Water Monitoring*, Appendix B. All final flow data collected by the USGS are forwarded to ARC for incorporation into the Leviathan Mine database.

Flow from the CUD was directed into the ARC treatment system beginning in mid July 2006. There was no flow from the CUD to the creek from then until early October 2006, except for a nine-day unauthorized discharge. Flows shown during this three-month period reflect discharges of treated effluent from ARC's treatment system that was directed through the CUD weir box. Many of the sites around the mine showed increased flows due to above average precipitation. The PUD flows showed significant increases compared to previous records.

Table 2. Flow Monitoring Locations

STATION LOCATION/DESCRIPTION	EQUIPMENT	USGS STARTUP DATE
Leviathan Creek above the mine (Station 1)	Continuous flow recorder and appurtenances, solar power supply.	October 98
Pit Under-Drain at the flow control structure (PUD)	Continuous flow recorder and appurtenances, solar power supply, telemetry.	October 99
Adit at the flow control Structure (Adit)	Continuous flow recorder and appurtenances, solar power supply, telemetry.	October 99
Pond 1 Stage	Continuous stage recorder and appurtenances, solar power supply, telemetry.	October 99
Pond 4 Stage	Continuous stage recorder and appurtenances, solar power supply, telemetry.	October 99
Channel Under-Drain (CUD)	Continuous flow recorder and appurtenances, solar power supply, telemetry.	October 99
Aspen Creek above the mine (Station 22)	Continuous flow recorder and appurtenances, solar power supply.	October 03
4L Creek above its confluence with Leviathan Creek (4L Creek)	Continuous flow recorder and appurtenances, solar power supply.	October 03
Leviathan Creek above its confluence with Aspen Creek (Station 15)	Continuous flow recorder and appurtenances, solar power supply, telemetry.	October 98
Aspen Creek above its confluence with Leviathan Creek (Station 16)	None. Monthly flow measurements to establish relationship w/STA 15.	October 98
Overburden (Aspen) Seep, above the Bioreactors (OS)	Continuous flow recorder and appurtenances, solar power supply.	October 98
Bryant Creek just below the confluence of Mountaineer and Leviathan Creeks (Station 25)	Continuous flow recorder and appurtenances, solar power supply.	October 98
Leviathan Creek just above the confluence of Mountaineer and Leviathan Creeks (Station 23)	Continuous flow recorder and appurtenances, solar power supply	November 99
Mountaineer Creek just above the confluence of Leviathan and Mountaineer Creeks (Station 24)	None. Monthly flow measurements to establish relationship w/STA 23.	December 99
Bryant Creek just above confluence with Doud Springs (Station 26)	Continuous flow recorder and appurtenances, solar power supply	August 01

4.2 Surface Water Monitoring

The Lahontan Water Board continued monthly water quality monitoring through the 2005-2006 water year (October 1, 2005 through September 30, 2006). The Lahontan Water Board's monthly surface water quality monitoring stations and measured parameters are summarized in Table 3. Surface water sampling and analysis was done in compliance with the *Sampling and Analysis Plan for Leviathan Mine Site Surface Water Monitoring (January 2004)* (SAP). The SAP is not included in this report, but copies may be obtained from the Lahontan Water Board. Surface water data collected by Lahontan Water Board staff is formatted and then forwarded to ARC for input into the Leviathan Mine database. Surface water data collected for this water year is summarized in the *Data Summary Report for 2006 Surface Water Monitoring*, included as Appendix B.

Table 3. Surface Water Quality Monitoring Stations

Lahontan Water Board Station	Site Description	Sampling Frequency	Parameters Measured
Station 1	Leviathan Creek above Leviathan Mine.	Monthly	Total and Dissolved Metals for aluminum, arsenic, calcium, cadmium, cobalt, chromium, copper, iron, magnesium, manganese, nickel, zinc; Total Dissolved Solids (TDS); Sulfate. Field: pH, temperature, electrical conductivity, and specific conductance.
Adit	Drainage from Tunnel #5 (the Adit), prior to entering evaporation ponds.	Monthly	Same as above.
Pit Under - Drain (PUD)	Drainage from shallow ground water collection pipes in pit, prior to entering evaporation ponds.	Monthly	Same as above.
Channel Under-Drain (CUD)	Discharge from Channel Under-Drain below Leviathan Creek concrete channel.	Monthly	Same as above.
Delta Seep (DS)	Seepage from the toe of the Delta Slope, located north of Pond 4.	Semi-annual	Same as above.
Station 15	Leviathan Creek, above the confluence of Leviathan and Aspen creeks.	Monthly	Same as above.
Station 16	Aspen Creek, above the confluence of Leviathan and Aspen creeks.	Monthly	Same as above.
4L Creek	4L Creek, just above the confluence of Leviathan Creek.	Semi-annual	Same as above.
Station 22	Aspen Creek above Leviathan Mine.	Monthly	Same as above.
Overburden Seep (OS)	Overburden seepage (a.k.a. Aspen Seep), above the bioreactors.	Monthly	Same as above.
Station 23	Leviathan Creek above the confluence of Leviathan and Mountaineer creeks.	Monthly	Same as above.
Station 24	Mountaineer above the confluence of Leviathan and Mountaineer creeks.	Monthly	Same as above.
Station 25	Bryant Creek below the confluence of Leviathan and Mountaineer creeks.	Monthly	Same as above.
Station 26	Bryant Creek above the confluence of Doud Springs and Bryant Creek.	Semi-annual	Same as above.

4.3 Meteorological Monitoring

The weather station located on the Lahontan Water Board's construction trailer near Pond 1, a Davis Integrated Sensor Suite, has been operational since installation in November 2002. The system measures the following conditions hourly: wind speed, wind direction, rainfall, outside temperature, outside humidity, ultraviolet radiation, and solar radiation. Lahontan Water Board staff downloaded data from this weather station quarterly and transmitted the data to ARC for incorporation into the master database for Leviathan Mine.

4.4 Monitoring Well-3

In addition to the routine monitoring activities, Lahontan Water Board staff also monitored the depth to groundwater in Monitoring Well-3 (MW-3) sporadically between January 2006 and March 2006. MW-3 is located in the northwest part of the pit floor, adjacent to the Pit Clarifier. Table 4 shows depth to water and corresponding groundwater elevations at MW-3 taken from August 2001 to March 2006.

There is a correlation between groundwater elevations measured in MW-3 and PUD flow rates, and to a lesser degree between MW-3 groundwater elevations and Adit flow rates. In general, as groundwater elevations increase, PUD and Adit flow rates increase.

Table 4. Monitoring Well-3 Water Elevations

Date	Depth to Water (ft)	Groundwater Elevation ^{f1} (ft asl)
8/23/2001	22.78	7053.61
6/26/2002	21.75	7054.64
9/25/2002	22.50	7053.89
11/7/2003	22.43	7053.96
4/20/2005	20.65	7055.74
4/28/2005	20.61	7055.78
5/10/2005	20.48	7055.91
5/17/2005	20.39	7056.00
5/24/2005	20.41	7055.98
6/1/2005	20.62	7055.77
6/13/2005	20.70	7055.69
7/1/2005	20.89	7055.50
7/11/2005	20.97	7055.42
8/11/2005	21.16	7055.23
1/05/2006	21.35	7055.04
1/24/2006	20.99	7055.40
2/22/2006	20.94	7055.45
3/16/2006	20.74	7055.65
3/22/2006	20.77	7055.62

f1 ...Bench Mark is the top of casing at 7076.39 feet above sea level (asl)

5. SITE MAINTENANCE

The Lahontan Water Board conducted site maintenance work during the 2006 field season in accordance with the Work Plan. These activities are necessary to prevent failures and to ensure proper performance of the 1985 pollution abatement system. Routine maintenance activities include repairing perimeter fencing, removing sediment from storm water ditches, covering exposed pond liners and minor road repair. Non-

routine maintenance for 2006 included road improvements along the California access road.

5.1 Repairing Perimeter Fencing

A barbed wire fence surrounds the majority of the site. The barbed wire fence does not continue along the high wall on the southeastern portion of the site where cattle cannot access. Instead, there is a fence limiting human access. During the 2006 field season, Lahontan Water Board staff inspected the entire fence line and noted the perimeter fencing required repairs in numerous locations. Lahontan Water Board staff repaired the perimeter fence throughout the 2006 field season.

5.2 Storm Water Conveyance and Road Maintenance

In the fall of 2006, the Lahontan Water Board hired a contractor to clean out portions of drainage ditches filled with sediment and improve drainage along the road around Pond 2 north. Minor grading was done on the north side of Pond 2 north in an effort to direct storm water and snow melt away from the terraced slope and into the concrete storm water conveyance system. In addition, sediment contained in the concrete lined ditch south and west of Pond 1 and to the west of Pond 4 was removed.

The USFS and Alpine County made significant improvements along the California access road between Highway 89 and Leviathan Mine under emergency contracts with the Lahontan Water Board. The improvement work was initiated in mid-May with the majority of improvement work being completed by mid-June 2006. The USFS returned in early July to complete road base placement and final grading.

Alpine County extended two 36-inch culverts (conveying Leviathan Creek) an additional 20 feet to improve the culvert crossing by heavy equipment. Additional road base material was placed and compacted in the roadway on both sides of the culvert crossing. Roadwork completed by the USFS included adding approximately 1600 tons of road base at several locations along the California access route, replacing a damaged culvert, and improving drainage along the road.

5.3 Covering Exposed Liner

Lahontan Water Board staff visually inspected cover material around each pond as a means to detect areas where earthen cover had eroded. Significant amounts of liner were exposed, and Lahontan Water Board staff directed the contractor removing sediment from concrete storm water conveyances to place material removed from conveyances over exposed liner.

6. REVEGETATION

6.1 Watering

Revegetation work conducted during August 2006 at Leviathan Mine consisted of hand watering the small trees and shrubs that were hand planted during the Delta Slope Stabilization Project in 2005.

6.2 Invasive Plant Control

The El Dorado County, Department of Agriculture (EDCDA) visited Leviathan Mine and applied herbicide (telar) on invasive plants in late July 2006. This year (2006), as in 2005 through 2002, the EDCDA sprayed to eradicate tall whitetop (*Lepidium latifolium*).

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